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Note

An efficient method for multiple radiative transfer computations and the lookup table generation

Menghua Wang

University of Maryland Baltimore County, NASA Goddard Space Flight Center, Code 970.2, Greenbelt, MD 20771, USA

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Abstract

An efficient method for the multiple radiative-transfer computations is proposed. The method is based on the fact that, in the radiative-transfer computation, most of the CPU time is used in the numerical integration for the Fourier components of the scattering phase function. With the new method, the lookup tables, which are usually needed to convert the spaceborne and the airborne sensor-measured signals to the desired physical and optical quantities, can be generated efficiently. We use the ocean color remote sensor Sea-viewing Wide Field-of-view Sensor as an example to show that, with the new approach, the CPU time can be reduced significantly for the generation of the lookup tables. The new scheme is useful and effective for the multiple radiative-transfer computations.
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1. Introduction

In the satellite and aircraft remote sensing, lookup tables are usually needed in the retrieval process to convert the sensor-measured signals to the desired physical and optical quantities. For example, the data processing for Sea-viewing Wide Field-of-view Sensor (SeaWiFS) [1], which was launched on August 1, 1997 for the ocean color remote sensing, uses lookup tables that were generated with ∼28,000 radiative-transfer model runs for the ocean–atmosphere system with various aerosol optical and microphysical properties, solar-sensor viewing geometries, and at the eight SeaWiFS spectral bands [2,3]. It requires tremendous efforts and computer resources to generate the lookup tables, and therefore limiting our ability to test and study with other atmospheric models for the lookup tables. The current SeaWiFS lookup tables were generated using the scalar radiative transfer computation (without polarization). It is even more difficult to generate lookup tables that include the polarization effects. This will usually require at least an additional order of factor in the resources for including

E-mail address: wang@simbios.gsfc.nasa.gov (M. Wang).

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the polarization effects in the radiative-transfer computations. In this note, an efficient method for the multiple radiative-transfer computations and for generating the lookup tables is described. First, a brief overview of the radiative transfer equation (RTE) with discussion of the solution method is provided. Next, a study for the CPU time distribution in the computation of the RTE is presented. We show that the most CPU time is used for the computation of the Fourier components for the scattering phase function (or phase matrix). Finally, a new approach for the multiple radiative-transfer computations is outlined. Results that demonstrate significant improvement in the CPU time efficiency for the multiple radiative-transfer computation are presented and discussed.

6. Summary

In an effort to increase efficiency in generating the lookup tables, a study has been carried out to understand the CPU time distribution in solving both the scalar and vector radiative transfer equations. It is found that the most of the CPU time is used in the numerical computation for the Fourier component of the phase function and phase matrix for the SRTE and VRTE case, respectively. Therefore, a new approach in constructing and running the SRTE and VRTE codes is proposed and tested with various cases. Results show that, to generate the SeaWiFS lookup tables with SRTE code, it requires about one month CPU time (one SGI IRIX64 computer) with conventional method, while it is reduced to about 5 days with the new method. On the other hand, it would need about three and half years to generate the SeaWiFS lookup tables with the VRTE code using the conventional method, while it can be reduced to about 139 days with the new approach. Therefore, by using the new method, it is possible to generate the lookup tables with including the polarization effects. This method is also useful and effective for the multiple radiative-transfer computations.